



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/663,838	09/17/2003	Masaaki Hirakawa	026390-00011	2691

4372 7590 08/25/2005
ARENT FOX PLLC
1050 CONNECTICUT AVENUE, N.W.
SUITE 400
WASHINGTON, DC 20036

EXAMINER

MARKHAM, WESLEY D

ART UNIT	PAPER NUMBER
----------	--------------

1762

DATE MAILED: 08/25/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/663,838

Applicant(s)

HIRAKAWA ET AL.

Examiner

Wesley D. Markham

Art Unit

1762

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 07 July 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-10 is/are pending in the application.
- 4a) Of the above claim(s) 9 and 10 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-8 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 17 September 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date 9/17/03.
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

1. Acknowledgement is made of the preliminary amendment filed by the applicant on 9/17/2003, in which Claims 3 and 5 – 8 were amended to remove multiple dependencies. **Claims 1 – 10** remain pending in U.S. Application Serial No. 10/663,838, and an Office action on the merits follows.

Election/Restrictions

2. Applicant's election of Group I, Claims 1 – 8, drawn to a method for preparing a graphite nanofiber, in the reply filed on 7/7/2005 is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP § 818.03(a)). As such, Claims 9 and 10 are withdrawn from further consideration pursuant to 37 CFR 1.142(b) as being drawn to a nonelected invention.

Priority

3. Receipt is acknowledged of papers submitted under 35 U.S.C. 119(a)-(d) (i.e., the certified copy of priority document JP 2002-270104, filed on 9/17/2002), which papers have been placed of record in the file.

Information Disclosure Statement

4. The IDS filed by the applicant on 9/17/2003 is acknowledged by the examiner, and the reference listed thereon has been considered as indicated on the attached copy of the PTO-1449 form.

Drawings

5. The drawings (2 sheets, 2 figures) filed by the applicant on 9/17/2003 are acknowledged and approved by the examiner.

Specification

6. The abstract of the disclosure is objected to because the phrase, "which comprises a raw gases are supplied on the surface of a substrate..." (lines 1 – 2) contains a typographical / translational error. It appears that the aforementioned phrase should read, "which comprises supplying raw gases on the surface of a substrate..."
Correction is required. See MPEP § 608.01(b).
7. The disclosure is objected to because of the following informalities:
 - The use of the trademark INVER 42 has been noted in this application (page 8, line 14). It should be capitalized wherever it appears and be accompanied by the generic terminology. Although the use of trademarks is permissible in patent applications, the proprietary nature of the marks should be respected and every effort made to prevent their use in any manner that might adversely affect their validity as trademarks.

Art Unit: 1762

- Page 9, lines 10 – 13: The phrase, “there is observed the formation of a catalyst layer in a thickness of about 1 μm ” appears to contain a typographical error and should read, “there is observed the formation of a non-fibrous layer in a thickness of about 1 μm ” in order to accurately correspond to the data in Table 1 and the SEM micrograph of Figure 2.

Appropriate correction is required.

Claim Objections

8. Claim 1 is objected to because of the following informalities: The phrase, “which comprises a raw gases are supplied on the surface of a substrate...” (lines 1 – 2 of the claim) contains a typographical / translational error. It appears that the aforementioned phrase should read, “which comprises supplying raw gases on the surface of a substrate...” Appropriate correction is required.

Claim Rejections - 35 USC § 112

9. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

10. Claims 1 – 8 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

11. Independent **Claim 1** (from which **Claims 2 – 8** depend) requires, in part, forming “a graphite nanofiber whose overall thickness is controlled and which comprises a graphite nanofiber layer and a non-fibrous layer”. This limitation seems to indicate that the thickness of “a graphite nanofiber” itself is controlled (e.g., the diameter or width of the fiber is controlled) and “a graphite nanofiber” itself comprises a graphite nanofiber layer and a non-fibrous layer. This language is confusing (i.e., how can “a graphite nanofiber” comprise a graphite nanofiber layer and a non-fibrous layer?) and does not correspond to the description of the applicant’s invention provided throughout the specification (see, for example, Figures 1 and 2, abstract, page 6, lines 1 – 5, and page 9, lines 1 – 15, which indicates that the deposited layer itself, not “a graphite nanofiber”, comprises a graphite nanofiber layer and a non-fibrous layer). As such, the scope of Claims 1 – 8 is unclear, and the claims are indefinite under 35 U.S.C. 112, second paragraph. For the purposes of examination only, the examiner has reasonably interpreted the claims to require forming a layer whose overall thickness is controlled and which comprises a graphite nanofiber layer and a non-fibrous layer.

12. **Claim 7**, from which **Claim 8** depends, requires, in part, forming lines consisting of “the foregoing catalyst metal” on the catalyst layer on a substrate. The limitation “the foregoing catalyst metal” does not have proper antecedent basis in the claims. Specifically, the catalyst previously recited in independent Claim 1 (from which Claim 7 depends) is not described as being a metal. Additionally, the claim seems to indicate that “the foregoing catalyst metal” is formed on “the catalyst layer”, thereby

suggesting that "the foregoing catalyst metal" and "the catalyst layer" are different things. However, only one catalyst ("the catalyst layer") has previously been recited in the claims. Additionally, the language of Claim 7 does not correspond to the description of the applicant's invention in the specification (see, for example, page 9, line 29 – page 10, line 11, which indicates that catalyst metal lines are formed on the substrate, not on another catalyst layer), thereby rendering the claims confusing. As such, the scope of Claims 7 and 8 is unclear, and the claims are indefinite. For the purposes of examination, the examiner has reasonably interpreted Claims 7 and 8 to be open to forming lines of a metal catalyst on the substrate and then selectively forming graphite nanofibers by CVD only on the metal lines thus formed.

Claim Rejections - 35 USC § 102

13. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

14. Claims 1 – 8 are rejected under 35 U.S.C. 102(b) as being anticipated by Ulvac Corp (JP 2002-115059 A).

15. Regarding independent **Claim 1**, Ulvac teaches a method for preparing a graphite nanofiber (Abstract), wherein the method comprises forming a catalyst layer for the growth of graphite nanofibers on the substrate, the catalyst layer having a desired thickness (Abstract, paragraphs [0008] – [0010], [0016], and [0031] – [0036]), and supplying raw gases on the surface of the substrate having the catalyst layer thereon in order to form the layer comprising the graphite nanofibers according to the CVD technique (paragraphs [0008] – [0019] and [0031] – [0036]), the layer having an overall thickness that is controlled (paragraphs [0008], [0019], [0032], and [0033]). Regarding **Claim 2**, Ulvac also teaches that the catalyst present in the catalyst layer is Fe, Co, or an alloy containing at least one of these metals (paragraphs [0009] and [0010]). Regarding **Claims 3 and 4**, Ulvac also teaches that the raw gas is a mixed gas comprising acetylene, CO, or carbon dioxide as a carbon-supply gas and hydrogen gas, wherein the ratio of the C-supply gas in the mixed gas ranges from 10 to 80% by volume (paragraphs [0008], [0012], [0014], [0024], and [0031]). Regarding **Claims 5 and 6**, Ulvac also teaches that the graphite nanofiber is prepared at a temperature in the range claimed by the applicant (e.g., 350 to 650° C) (paragraphs [0013], [0019], [0031], and [0032]) and for a time period within the range claimed by the applicant (i.e., 1 to 60 minutes) (paragraph [0032]). Regarding **Claims 7 and 8**, Ulvac also teaches that the method is carried out by forming catalyst metal lines on the substrate on which any graphite nanofiber cannot be formed and then selectively forming graphite nanofibers only on the metal lines according to the CVD method, wherein the substrate is glass or an Si wafer

(Abstract, paragraphs [0009], [0010], [0016], [0018], [0031], and [0035]). Ulvac does not explicitly teach that the layer grown by the process comprises a graphite nanofiber layer and a non-fibrous layer. However, the process of Ulvac is identical to the applicant's claimed and disclosed process (i.e., the process of Ulvac uses the same substrate material, the same catalyst material, the same catalyst layer/line thickness, the same raw gases in the same ratio, the same process temperature, the same process pressure, and the same growth time). Therefore, since the process of Ulvac is identical to the process used by the applicant, the process of Ulvac would have inherently produced a layer comprising a non-fibrous layer as well as the nanofiber layer. The examiner's position is supported by the data presented by the applicant in Table 1 of the specification which clearly shows that relatively thick catalyst layers (e.g., from 20 to 50 nm thick) function to grow both a nanofiber portion of the layer and a non-fibrous portion of the layer in a CVD process. The catalyst layer thicknesses that grow both a nanofiber portion of the layer and a non-fibrous portion of the layer in a CVD process (e.g., 20 nm, 50 nm, etc.) are explicitly taught by Ulvac (Abstract, paragraph [0032]). Please note that the fact that applicant has recognized another advantage (i.e., that a CVD process using a relatively thick catalyst layer produces both a non-fibrous layer and a nanofiber layer) which would flow naturally (inherently) from following the suggestion of the prior art (i.e., performing the CVD process taught by Ulvac) cannot be the basis for patentability. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985).

Art Unit: 1762

16. Claims 1 – 5 are rejected under 35 U.S.C. 102(e) as being anticipated by Bower et al. (USPN 6,630,772).

17. Regarding independent **Claim 1**, Bower et al. teaches a method for preparing a carbon nanotube (i.e., a “graphite nanofiber”) (Abstract, Col.5, lines 47 – 52), wherein the method comprises forming a catalyst layer for the growth of graphite nanofibers on the substrate, the catalyst layer having a desired thickness (Col.4, line 1, Col.6, lines 45 – 47, Col.6, line 57 – Col.7, line 1), and supplying raw gases on the surface of the substrate having the catalyst layer thereon in order to form the layer comprising the graphite nanofibers according to the CVD technique (Col.6, lines 33 – 56), the layer having an overall thickness that is controlled (Col.7, lines 22 – 25) and comprising a graphite nanofiber layer and an amorphous carbon (i.e., “non-fibrous”) layer (Col.4, lines 2 – 9, Col.6, lines 51 – 56, Col.7, lines 1 – 31). Regarding **Claim 2**, Bower et al. also teaches that the catalyst present in the catalyst layer is Fe, Co, or an alloy containing at least one of these metals (Col.6, lines 45 – 47 and 63). Regarding **Claims 3 and 4**, Bower et al. also teaches that the raw gas is a mixed gas comprising acetylene, CO, or carbon dioxide as a carbon-supply gas and hydrogen gas, wherein the ratio of the C-supply gas in the mixed gas ranges from 10 to 80% by volume (Col.6, lines 33 – 45). Regarding **Claim 5**, Bower et al. also teaches that the graphite nanofiber is prepared at a temperature in the range claimed by the applicant (e.g., 350 to 650° C) (Col.6, lines 43 and 55; Col.7, line 17).

Art Unit: 1762

18. Claims 1 and 2 are rejected under 35 U.S.C. 102(b) as being anticipated by Dai et al. (WO 00/63115 A1).

19. Regarding independent **Claim 1**, Dai et al. teaches a method for preparing a carbon nanotube (i.e., a "graphite nanofiber") (Abstract, page 9, lines 14 – 17), wherein the method comprises forming a catalyst layer for the growth of graphite nanofibers on the substrate, the catalyst layer having a desired thickness (page 3, lines 20 – 26, page 6, lines 15 – 17), and supplying raw gases on the surface of the substrate having the catalyst layer thereon in order to form the layer comprising the graphite nanofibers according to the CVD technique (page 3, lines 15 – 18, page 4, lines 24 – 30, page 6, lines 22 – 26, page 7, lines 8 – 20, page 10, lines 10 – 21), the layer having an overall thickness that is controlled (page 1, lines 1 – 6) and comprising a graphite nanofiber layer (i.e., the carbon nanotube layer(s)) and one or more additional layers made of metal, metal oxide, semiconductor material, polymers, and/or pyrolysis resistant material (i.e., a "non-fibrous layer") (pages 6 and 7, and Example 4). Regarding **Claim 2**, Dai et al. also teaches that the catalyst present in the catalyst layer is Fe, Co, or an alloy containing at least one of these metals (page 3, lines 20 – 25, page 6, line 17).

Claim Rejections - 35 USC § 103

20. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the

Art Unit: 1762

invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

21. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

22. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bower et al. in view of Dai et al.

23. Bower et al. teaches all the limitations of **Claim 6** as set forth above in paragraph 17, except for a method wherein the preparation of the graphite nanofiber is carried out for 1 to 60 minutes. Specifically, Bower et al. is silent regarding the carbon nanotube growth time but does generally teach that the layer can have a widely variable overall thickness (Col.7, lines 23 – 25). Dai et al. teaches that, in the art of growing carbon nanotube films by CVD, the conditions will depend on the type of carbon containing gas used and the type of catalyst, as well as the length and density of the nanotubes required. In this regard, it is possible to vary the conditions, such as temperature, time, pressure, or flow rate to obtain nanotubes having different characteristics (page 4, lines 3 – 7), and doing so is within the skill set of one in the

art (page 4, lines 13 – 14). In other words, Dai et al. teaches that the growth time is a result / effective variable that influences the characteristics (length, density, etc.) of the carbon nanotubes grown in a CVD process. Therefore, it would have been obvious to one of ordinary skill in the art to optimize the growth time in the process of Bower et al. as a result / effective variable through routine experimentation. The exact growth time would, of course, depend on the characteristics of the nanotubes (length, density, etc.) desired by the purveyor in the art.

24. Claims 7 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bower et al. in view of Ulvac.

25. Bower et al. teaches all the limitations of **Claims 7 and 8** as set forth above in paragraph 17, except for carrying-out the method by forming catalyst metal lines on the substrate on which any graphite nanofiber cannot be formed and then selectively forming graphite nanofibers only on the metal lines according to the CVD method. Please note that the substrate of Bower et al. can be a Si wafer, as recited in Claim 8 (Col.5, lines 14 – 21, Col.11, line 5). Additionally, Bower et al. teaches that the method is generally used to produce field emission devices comprising carbon nanotubes (Col.1, lines 14 – 15). Ulvac teaches that, in the art of growing carbon nanofibers on a substrate to produce a field emission device, the nanofiber growth catalyst layer can be formed in a pattern such as lines so that the nanofibers selectively grow only on the patterned metal catalyst lines and not on the rest of the substrate, thereby controlling the location of the nanofiber layer (i.e., forming the

nanofibers on only those portions of the substrate where electron emissive material is required) (Abstract, paragraphs [0009], [0010], [0016], [0018], [0031], and [0035]). Therefore, it would have been obvious to one of ordinary skill in the art to form catalyst metal lines on the substrate on which any graphite nanofiber cannot be formed and then selectively form the carbon nanotube layer only on the metal lines by the CVD method in order to produce the field emission device of Bower et al. in order to advantageously form the nanofibers on only those portions of the substrate where electron emissive material is required as opposed to the entire substrate.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Morita et al. (US 2004/0241439 A1) teaches a pyrolysis method used to make a fine carbon fiber mixture that also contains non-fibrous carbon material. Patterson et al. (USPN 6,181,055) teaches making an FED by using CVD to deposit two layers of carbon-based material, each layer having different characteristics. Choi et al. (USPN 6,504,292) teaches making an electron emitter by depositing carbon nanotubes onto a substrate and then depositing a conductive metal layer on the carbon nanotubes. Pavlovsky et al. (USPN 6,664,728) teaches improving field emission characteristics by incorporating nitrogen into a portion of the carbon nanotube emitters grown by CVD. Dimitrijevic et al. (US 2001/0024078 A1) teaches depositing carbon nanotubes and then coating the nanotubes with DLC in order to produce an electron emitter. Merkulov et al. (US 2002/0117951 A1) teaches making an electron emitter by forming carbon fibers

Art Unit: 1762

having an expanded base. Blyablin et al. (USPN 6,577,045) teaches making an electron emitter by sequentially depositing two carbon films, the first comprising graphite and having nano-barbs and the second being diamond.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Wesley D. Markham whose telephone number is (571) 272-1422. The examiner can normally be reached on Monday - Friday, 8:00 AM to 4:30 PM.

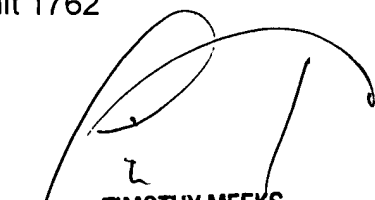
If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tim Meeks can be reached on (571) 272-1423. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



WDM

Wesley D Markham
Examiner
Art Unit 1762



TIMOTHY MEEKS
SUPERVISORY PATENT EXAMINER